



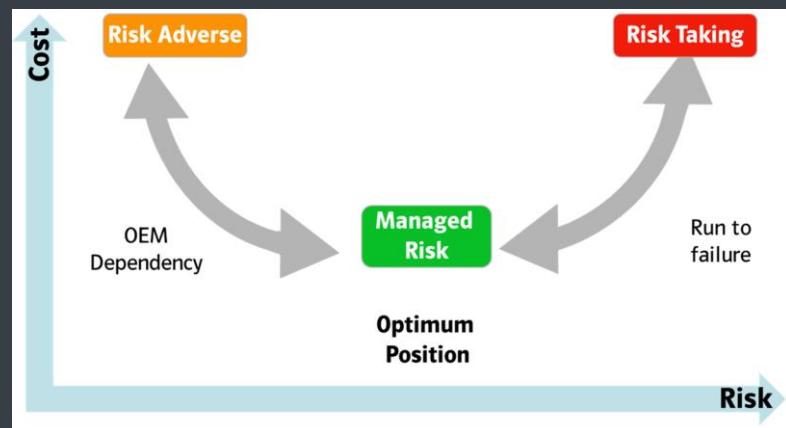
Erfahrungsbericht aus einem CM-Überwachungszentrum

– mit Beispielen aus der Überwachungspraxis

Holger Fritsch & Kilian Krügel & Demirel Arik, Bachmann Monitoring GmbH



27. Windenergietage, 06. bis 08. November 2018 in Linstow



Erfahrungsbericht aus einem CM-Überwachungszentrum

mit Beispielen aus der Überwachungspraxis

Holger Fritsch & Kilian Krügel & Demirel Arik, Bachmann Monitoring GmbH

- Bachmann Remote Monitoring Center in überblick
- Die Herausforderung bei CBM
 - Kernaufgabe
 - Beispiel
- Die bewährte & etablierte CM-Lösung
 - Konzept
 - Beispiele
- Outlook
 - Smart Maintenance Plattform
 - Ganzheitlich, Wissensbasiert, Innovative

(1Min)

(4Min)

(8Min)

(4Min)



Erfahrungsbericht aus einem CM-Überwachungszentrum

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Service by Bachmann

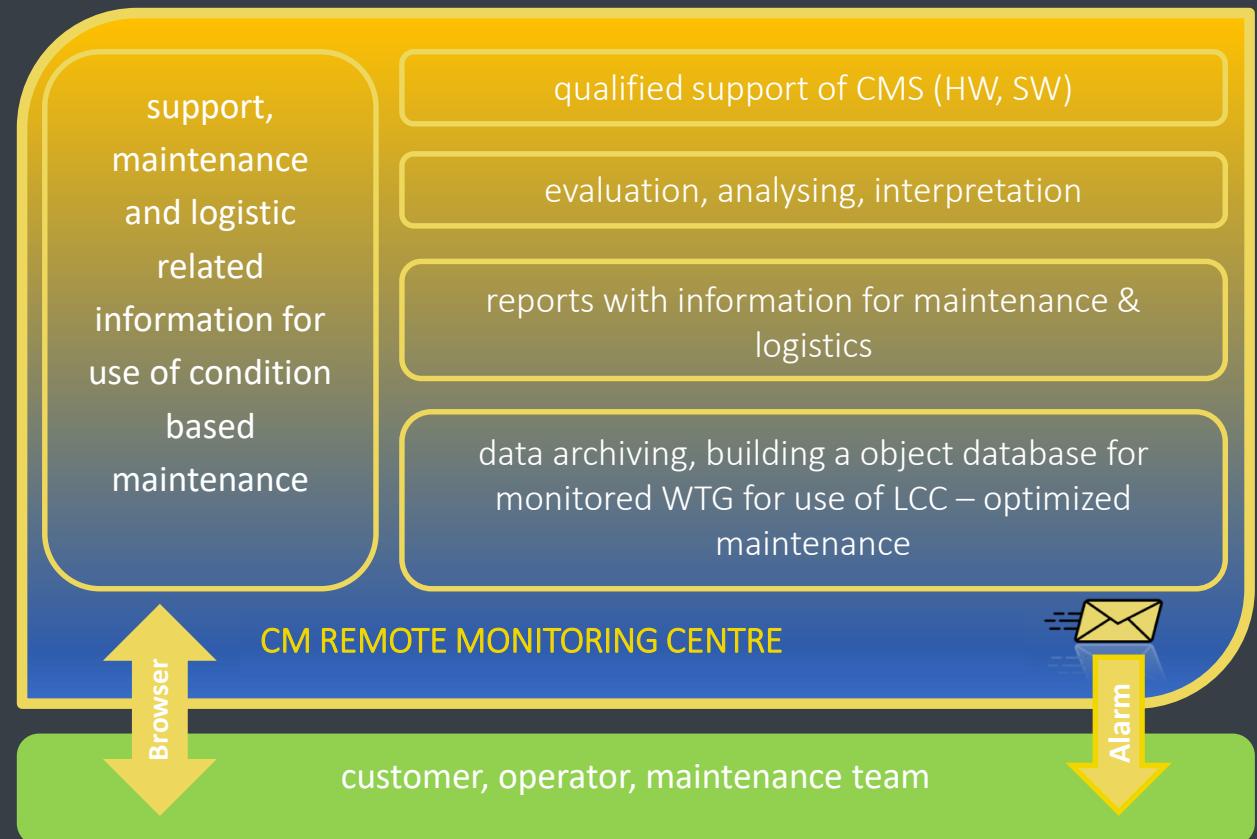
- DNV-GL-certified service centre (24 staff)
- ISO 18436-2 certified vibration analysts
(CAT II, CAT III, CAT IV)
- References Wind
 - 250kW – 8 MW (On- and Offshore)
 - Large and small O&M companies
 - Large and small utilities
 - Large and small OEM's
- Wind projects all over the world
(from 2 to >1000 WTG)
- Marine applications



CMS in WTG world wide distributed
data acquisition, analysing, threshold monitoring,
automated data delivery to remote monitoring centre

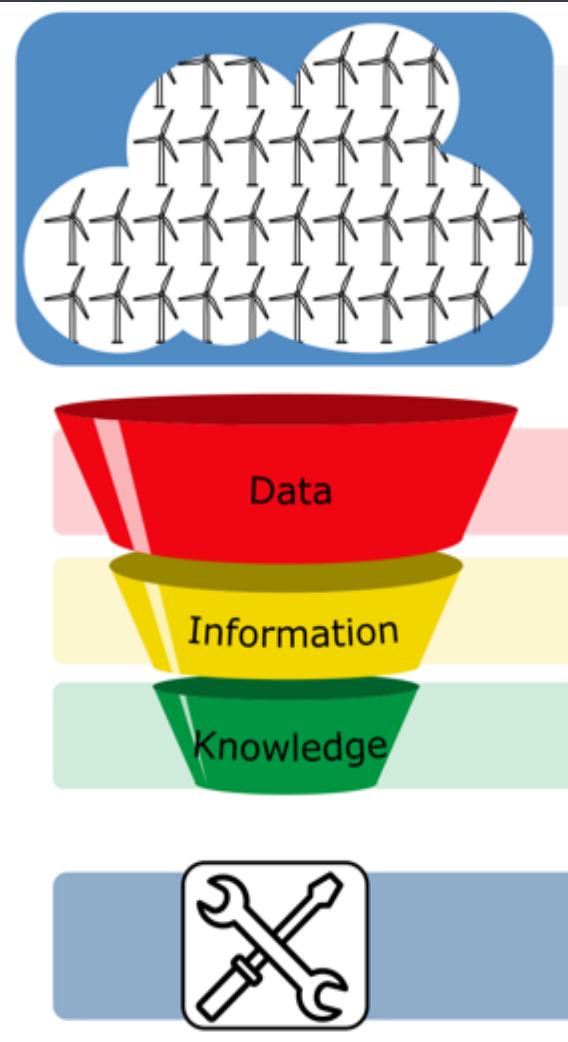


secured communication to world
wide distributed CMS



Handling Complexity

Condition Based Maintenance



Remote Monitoring Process

Handling Complexity

DATA ACQUISITION

- Bachmann has currently over **5,000 turbines** in Remote Monitoring service. Each system is characterised by **600-800 fault indicators**.
- CMS raw data is acquired using a sensor setup adapted to your requirements. The data comprise e.g. acceleration, velocity and displacement signals.
- The raw data is processed by our PLC unit, which computes the fault indicators used for the system diagnosis.

Handling Complexity

STORAGE

- WebLog Server
The CMS data is stored on our WebLog server. Optionally you can store the data on your own hosting solution.
- WebLog Software
Our web-based software gives you access to your data via PC or your mobile devices. You can observe individual turbines or recall statistical information on fleet level.
- Data API
Direct access to your data. Download and analyse your data on your own maintenance tools.

Handling Complexity

DIAGNOSIS

- Incident triggered trend observation:
 - High-level approach
 - Component specific, fault indicators
 - Application of warning and alert thresholds
- In-depth analysis:
 - Low-level approach
 - Identification and interpretation of spectral patterns according to the standard of ISO 18436-2 certified vibration analysts.
- WebLog Expert:
 - CMS configuration & data analysis tool
 - Integrated ticket and reporting system

Handling Complexity

REPORTING

- Bachmann's incident triggered ticket system ensures that no fault goes unseen by your team. Alarms triggered by machine faults, or increases in vibration levels are sent to maintenance teams via a ticket system.
- All turbine faults and maintenance activities are logged within WebLog, creating a comprehensive maintenance record for each turbine.
- With each diagnostic report, customers benefit from a summary of our findings, let's say fault diagnosis findings on turbine fleet level. Moreover, we provide recommended maintenance actions to follow and all relevant supporting CMS data.

Handling Complexity

YOUR ACTION

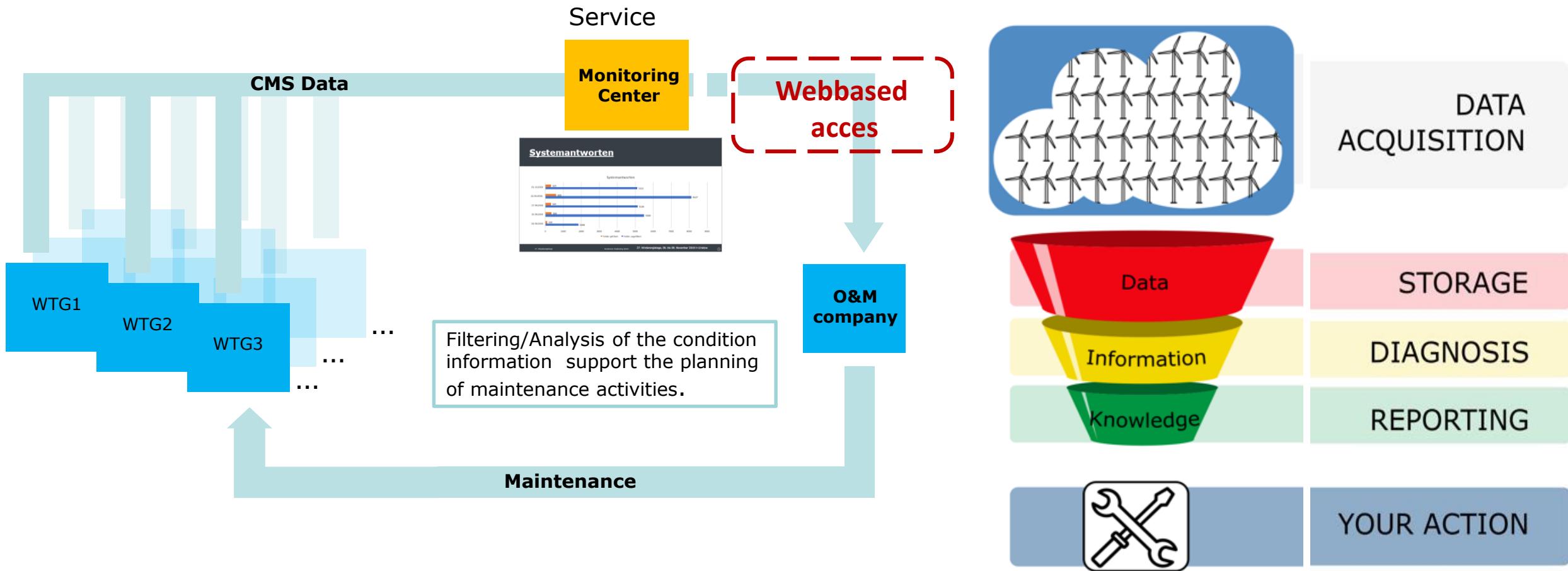
- Condition based maintenance significantly reduces system downtime, secondary failures and operational expenditures.
- Our web-based software tool WebLog gives you a comprehensive overview on your turbine condition. Moreover, it sends an alert in case of any system abnormality.
- Bachmann's reporting service provides you with all necessary information to plan your actions – both on turbine and fleet level.

Remote Monitoring Process Bachmann Group of Companies 27. Windenergietage, 06. bis 08. November 2018 in Linstow



Remote Monitoring Service

CMS based maintenance process



Bachmann CMS – Experience counts



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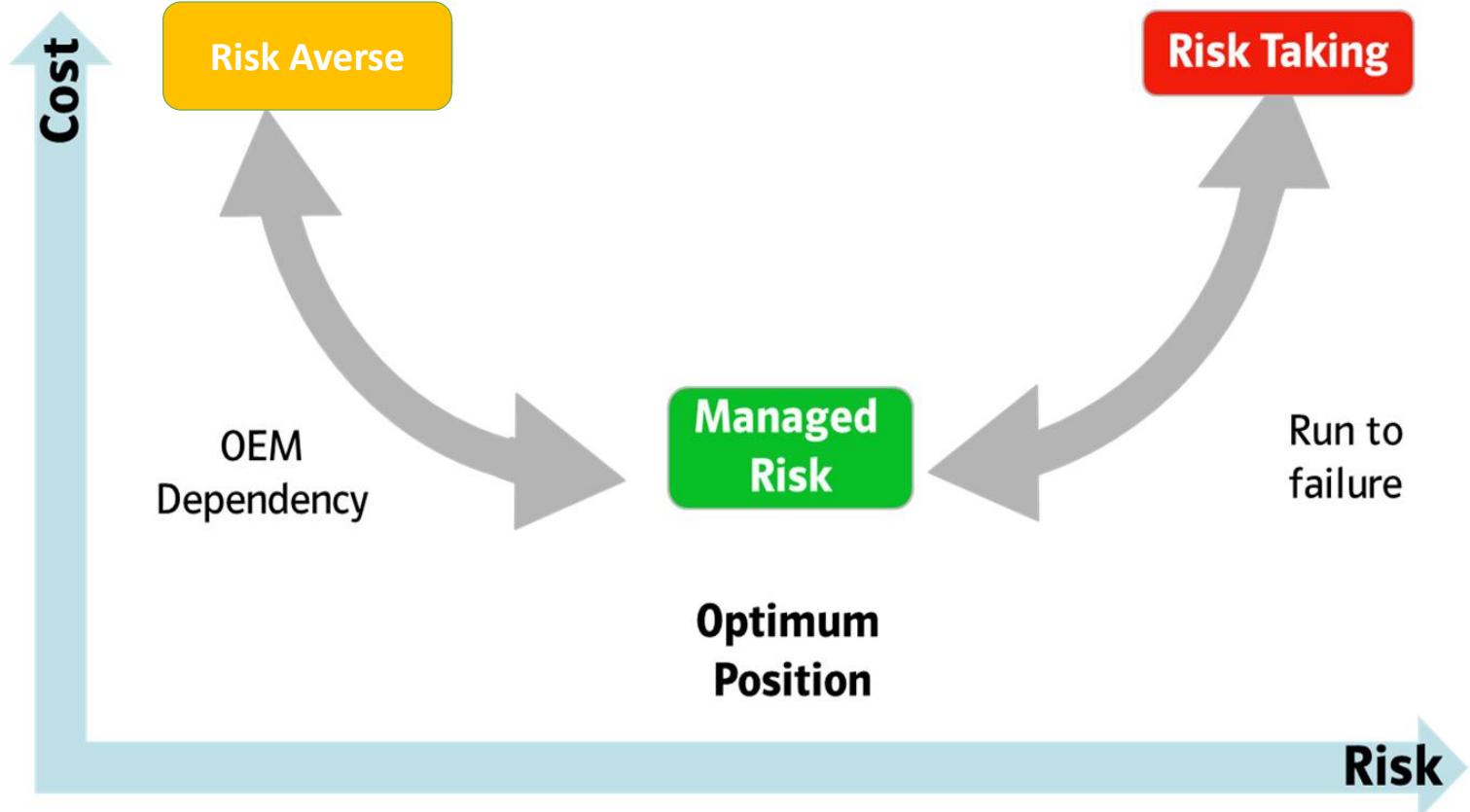
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Kernaufgabe Condition Monitoring

Optimum position of managed risk



Condition Monitoring

Why do we do it?

- Condition Monitoring
 - Monitoring of selected parameters to assess the condition of the machine.
- To be of use it must:
 - Produce a measurable, non catastrophic effect
 - Give sufficient warning time before failure
 - Be reproducible
 - Give a signature from which a diagnosis can be made
- The ultimate aim:
 - Provide a maintenance solution for the plant which gives minimum cost and managed risk

Condition Monitoring
Why do it?

- Early indication of damage indications
- More time to plan
- Targets necessary maintenance
- Allows early maintenance
- Informs customers about their machines
- Allows OEM to be challenged
- Enables operation under fault conditions
- Reduces risk

SAVES MONEY

- Early indication of damage indications
- More time to plan
- Targets necessary maintenance
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- Reduces risk

Why Monitor Condition

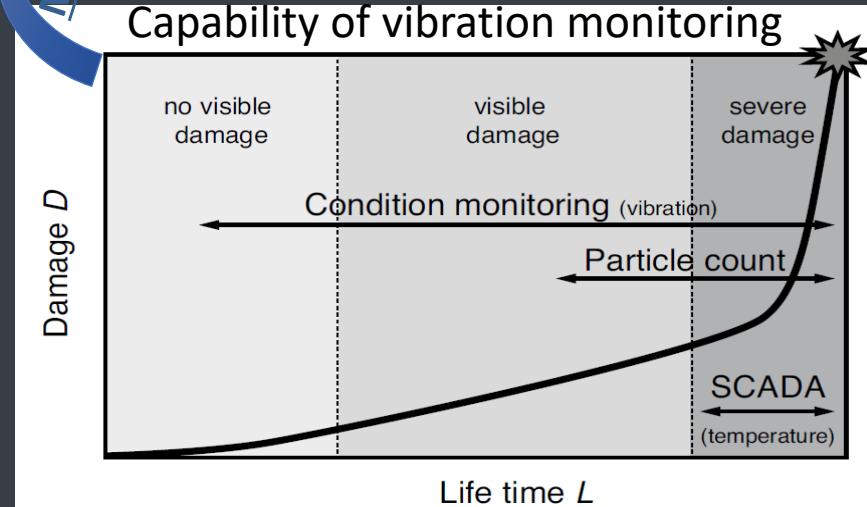
Bachmann Group of Companies

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Beispiel zu Herausforderung & Problembeschreibung

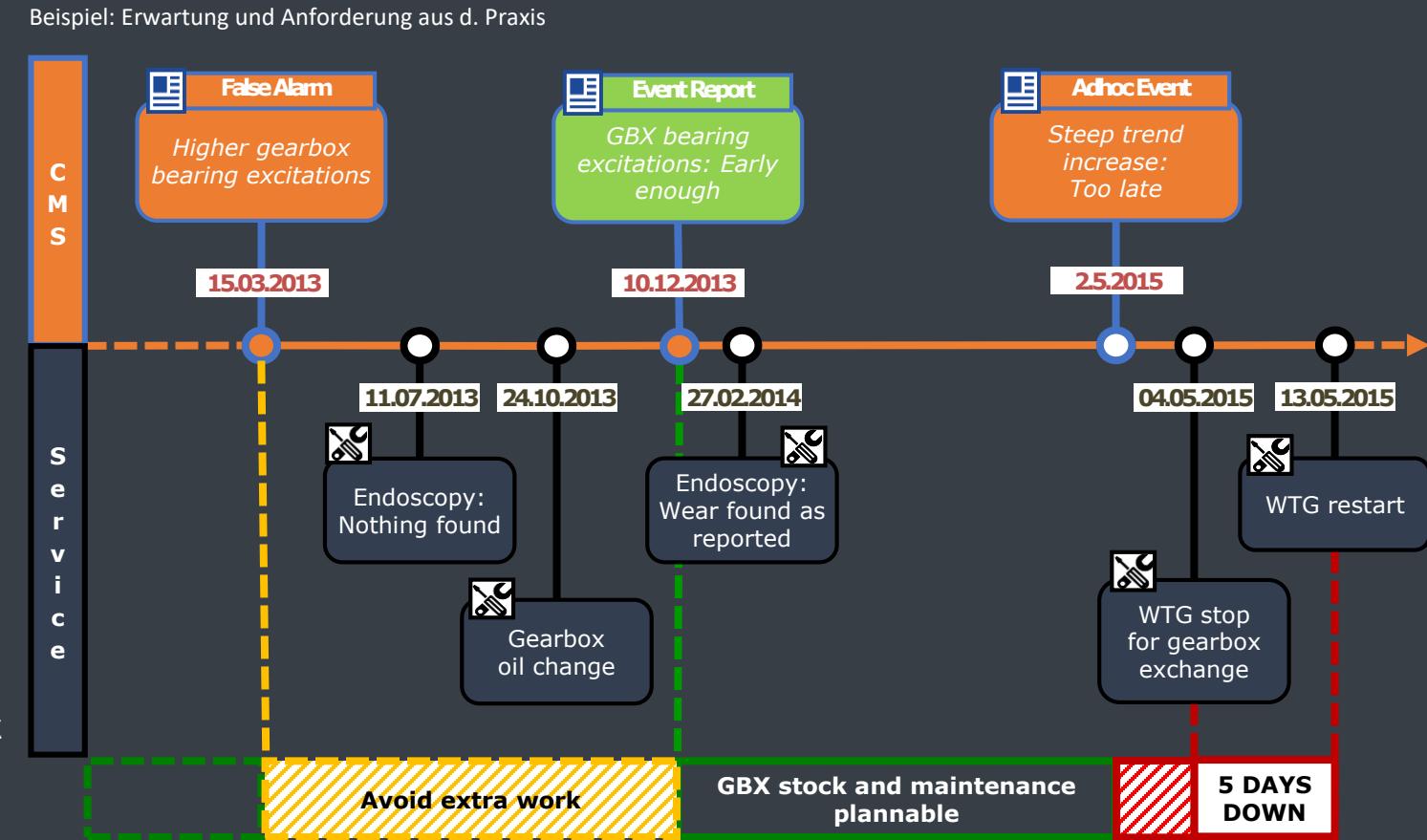
- zu früh → „False Alarm“ (no visible damage)
- zu spät → Risiko für Folgeschäden (z.B. Zahnbruch)

WANN IST DER RICHTIGE ZEITPUNKT ?



Richtige Zeitpunkt = visible damage

Nur möglich bei normierten Kennwerten mit gut dokumentierten Schadensbildern = Erfahrungsdatenbank



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CMS for Windturbines

- Basics -

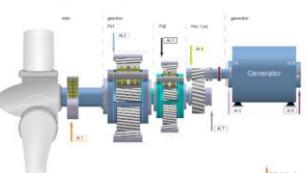
CMS Basics

Overview

CMS Basics

Signal comprehension: Sensor positions

The drive train of the wind turbine is divided into measuring areas in which each sensor takes its monitoring task. The sensor positions are chosen according to the design of the wind turbine so that there is a firm and solid connection.

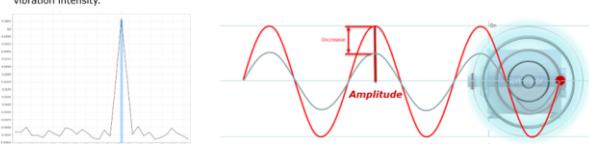


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CMS Basics

Signal comprehension

Each component generates sound which consists of characteristic frequencies. The different frequency components can be separated and identified by comparison with known frequencies. The amplitude of the signal shows the degree of vibration intensity.



If the sound intensity increases during operation, we see that in an amplified vibration signal.

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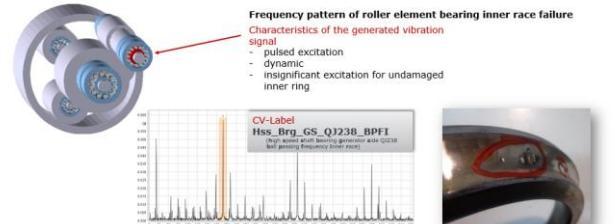
CMS Basics

Characteristic Values (CVs): Searchbands

Frequency pattern of roller element bearing inner race failure

Characteristics of the generated vibration signal

- pulsed excitation
- dynamic
- insignificant excitation for undamaged inner ring

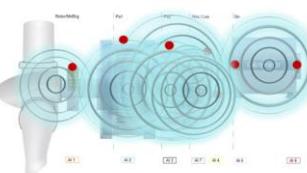


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CMS Basics

Signal comprehension

The signal sources and distribution of the operation noises on the drive train.



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CMS Basics

Characteristic Values (CVs)

- Characteristic values (CVs) denote fault indicators on component level.
- CVs are derived from kinematic data and comprise:
 - Time series information (e.g. RMS, mean, peak)
 - Spectral information from amplitude spectrum
 - Spectral information from envelope spectrum
- CVs are trended to monitor the condition of the turbine's individual components and subcomponents.

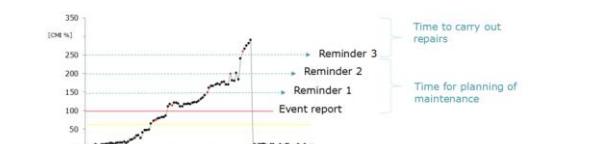
Example: Labeling subcomponents of a HSS bearing



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CMS Basics

Characteristic Values (CVs): Trends and Monitoring Activities



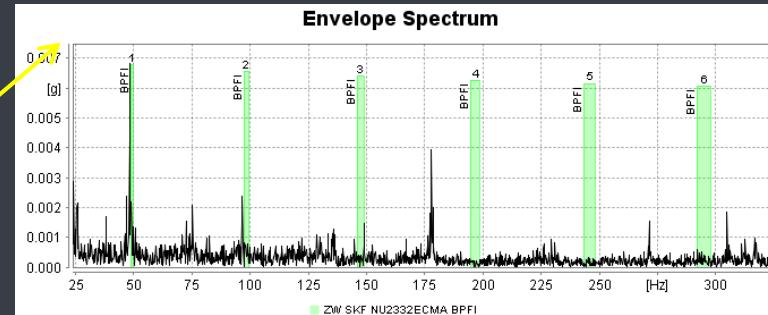
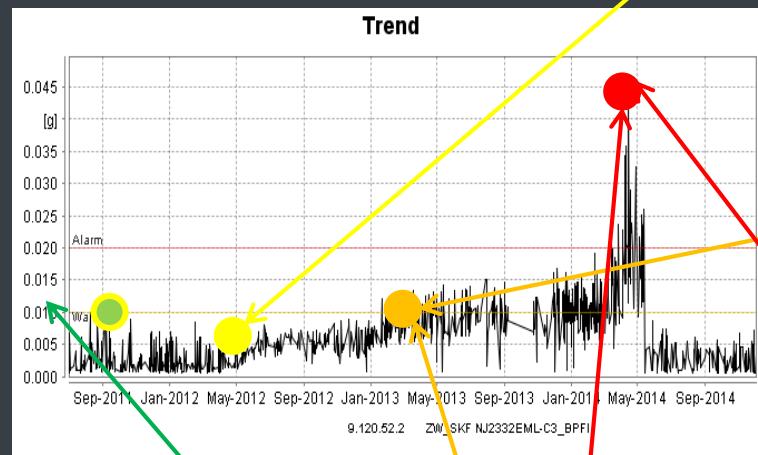
Summary you can see a trend development of a characteristic value with the red activity points.

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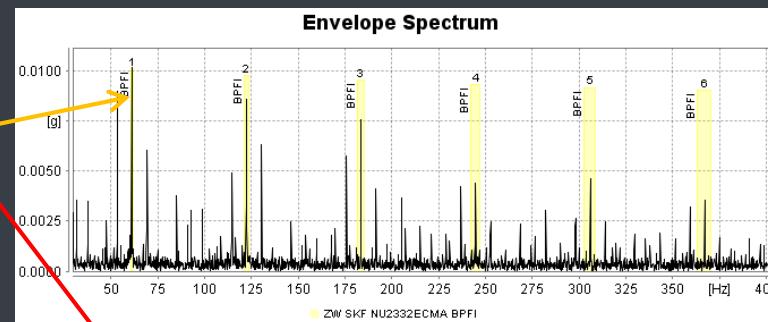


Trend Diagnosis

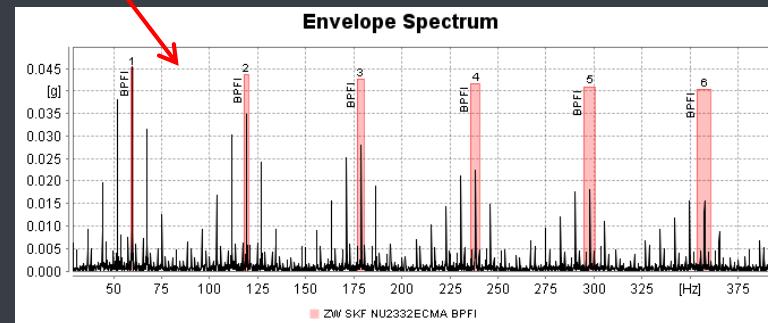
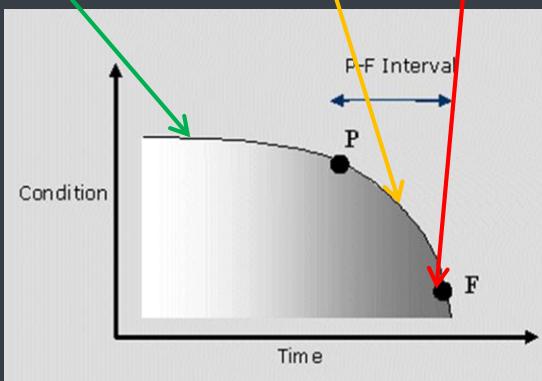
Increasing trend of an inner ring roll over frequency intermediate shaft bearing



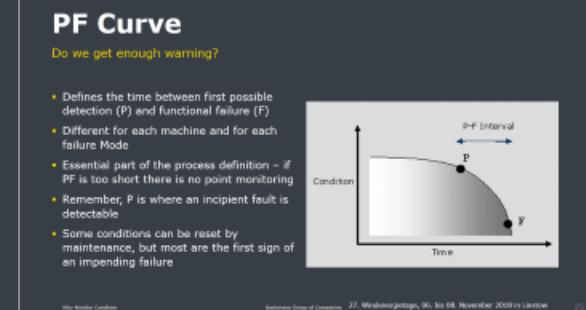
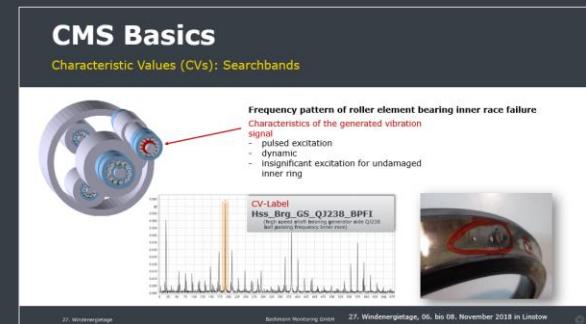
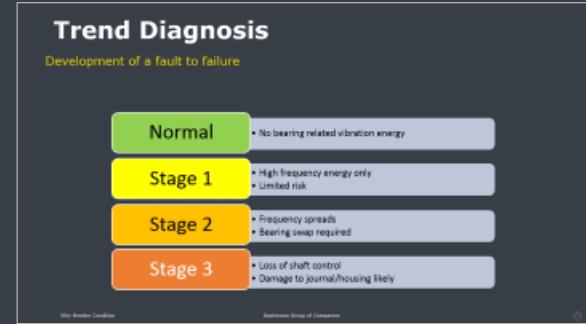
June 2012
0,007g



March 2013
0,010g



April 2014
0,045g



Erfahrungsbericht aus einem CM-Überwachungszentrum

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(4Min)

- Zustandsbericht
- Handlungsempfehlung

Bericht

Ursachen-analyse

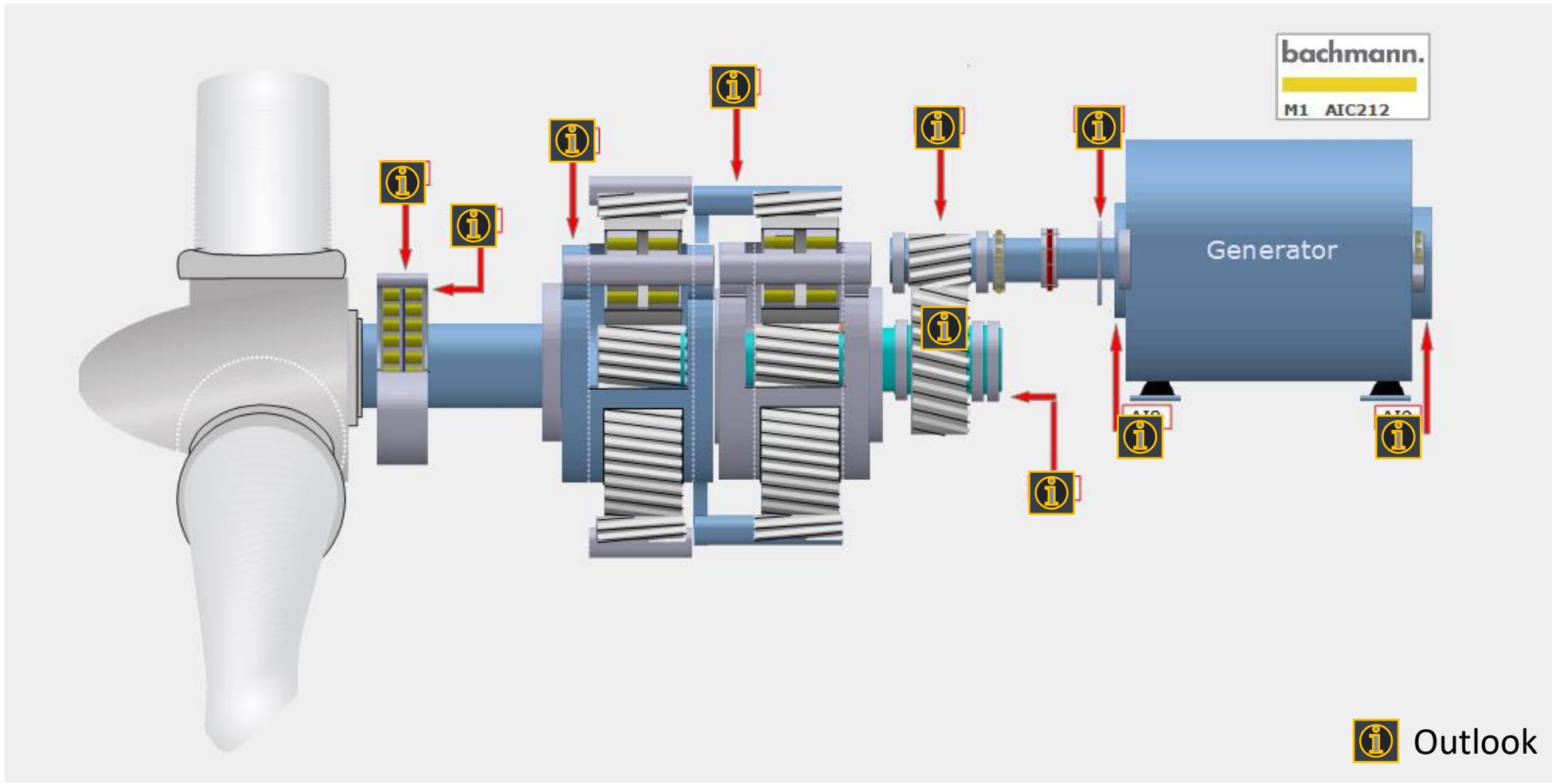
- Diagnose
- Expertise

Ereignis

- Alarm
- Störung



Case Studies



Outlook

- Main Bearing
- Unbalance
- Planetary Gearbox
- Planetary Stage Bearing
- Helical Stage Gearbox
- LSS bearing
- HSS Bearing
- Coupling
- Generator

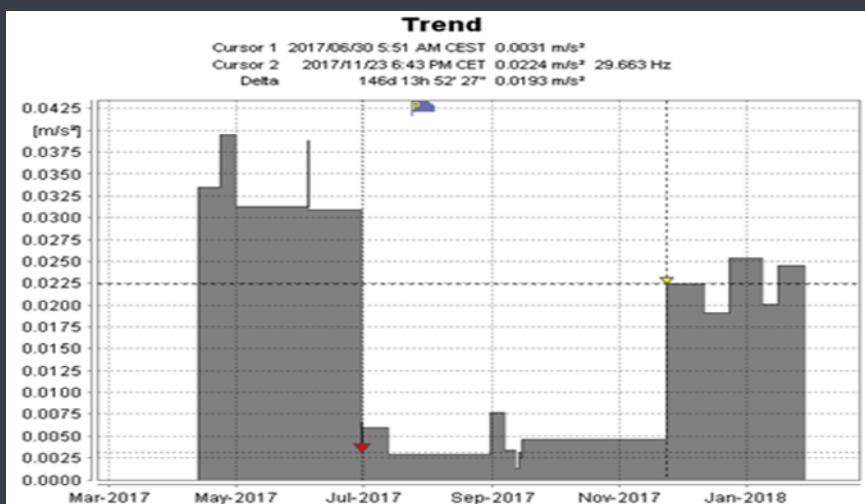
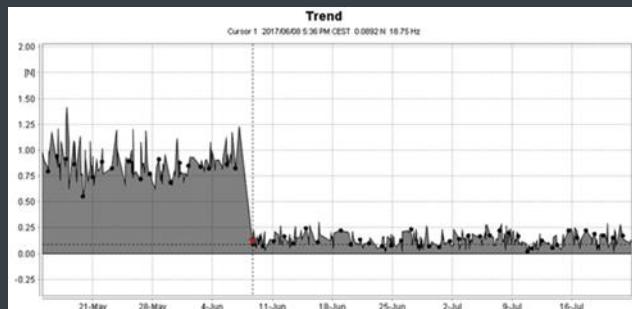


Case Study: Rotor Unbalance (Aerodynamic)

All aerodynamic unbalances corrected

Ongoing trial of mass unbalance system

Aerodynamic unbalance re-appeared after a few months



Customer requested more exact time for change

We identified a 6 hour window

Technician on site applying loctite to pitch system

Rapid warning provided

Reduced loss of earnings

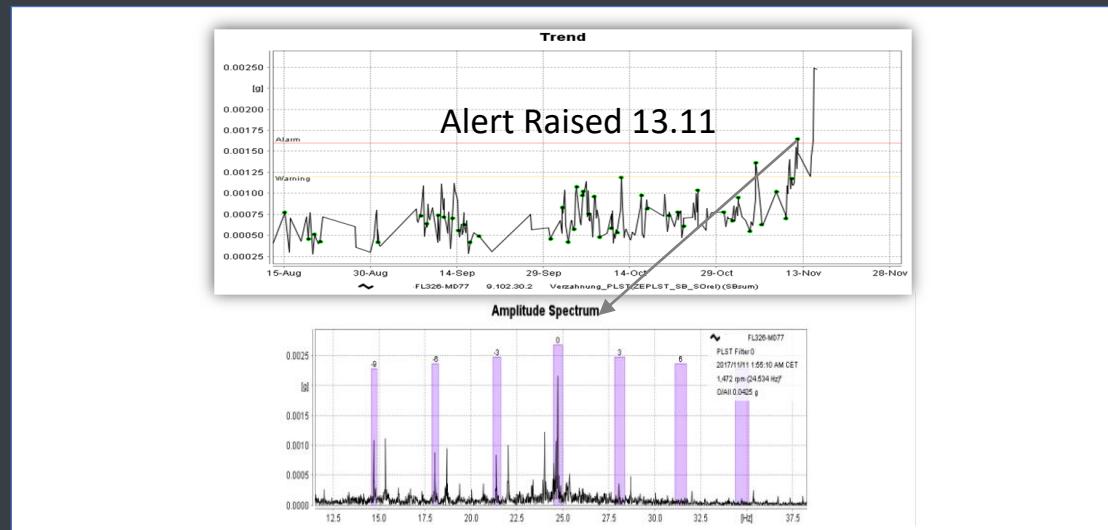
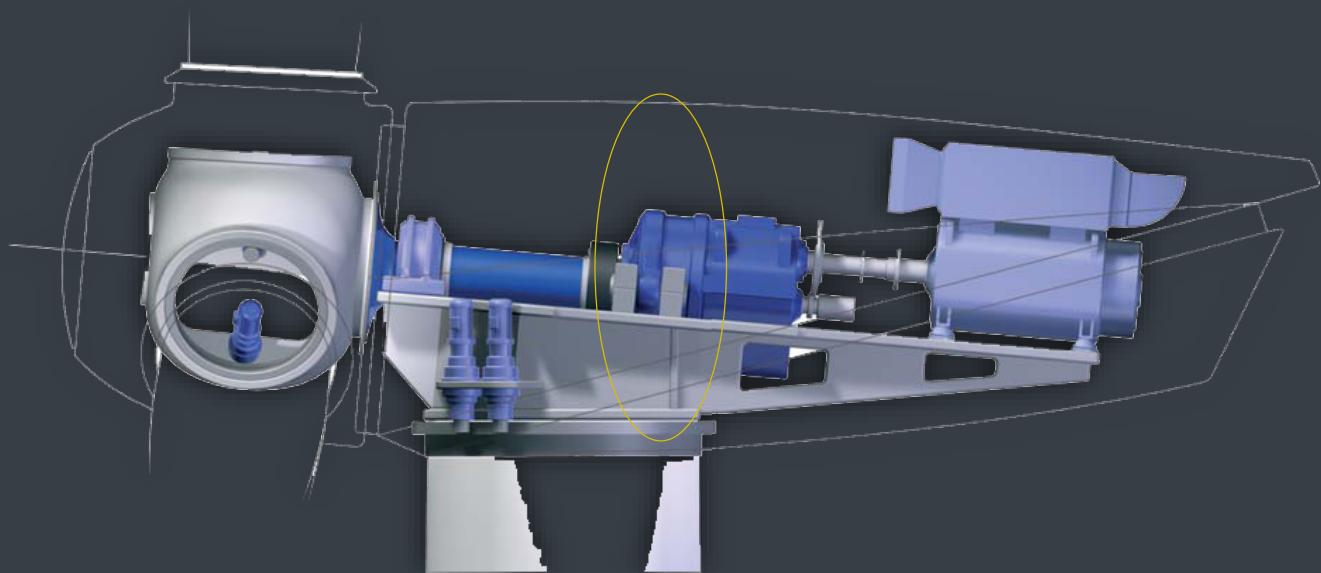
To quote the customer: „Das System rockt!“

EN: “The system rocks!”



Case Study: Planetary Stage Tooth Damage

Early detection of planetary stage damage
Trend in CV relating to TM frequency.
FFT indicated damage on the sunwheel
Levels and trend indicate fault progressing
Customer informed of finding



Customer inspected gearbox
The sun gear was found to be "broken"
Gearbox exchange planned
Two weeks advance warning
Planetary stage catastrophic failure avoided
Refurbishment of gearbox possible
Saving of €50k



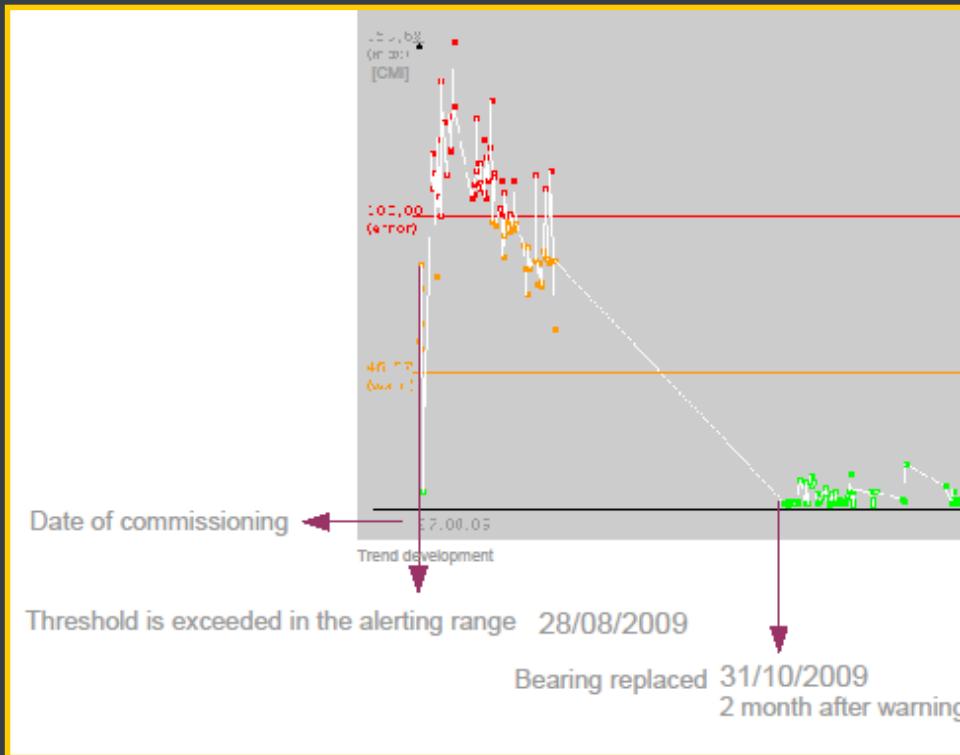
Case Study: Planetary stage bearing

Sudden increase at characteristic frequency

Shortly after commissioning

Inspection recommended

Endoscope identified sun bearing inner race failure

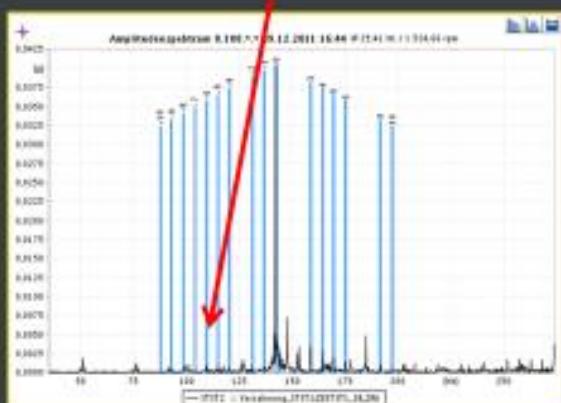
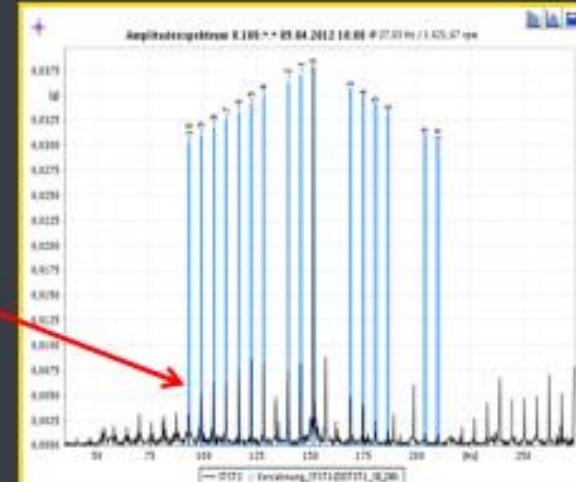
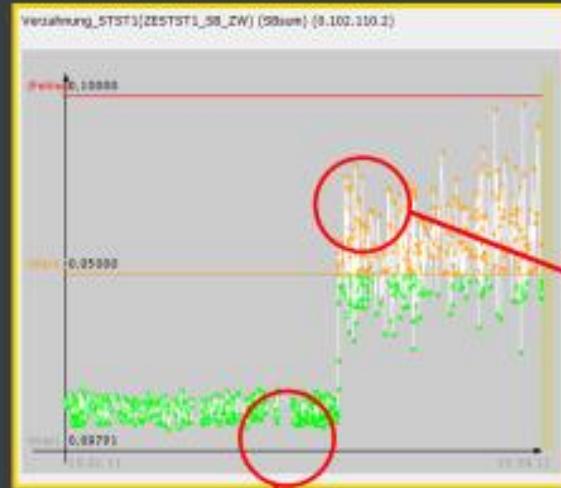


Bearing exchange arranged
Advance warning minimised damage
Gearbox did not need replacement



Case Study: Helical stage gearbox

Example: Tooth Damage IMS Pinion



Example of damage



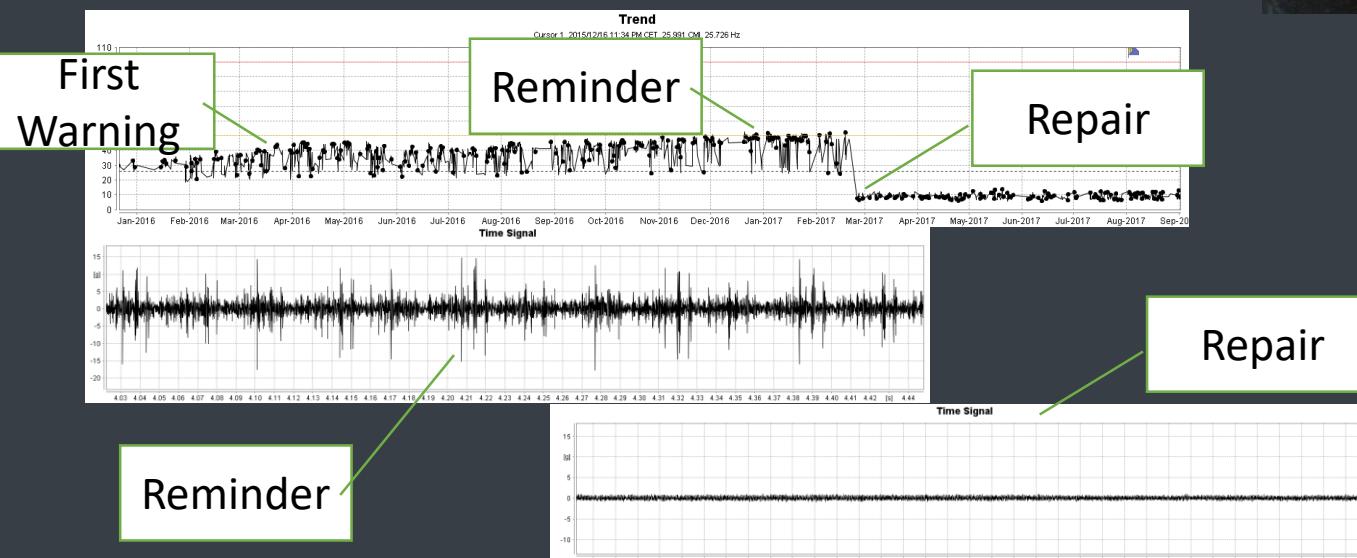
Bachmann Monitoring GmbH

Sudden change in tooth meshing
Customer inspected gears
Early warning of tooth damage
Gear could be replaced
No consequential damage



Case Study: LSS Bearing

High vibration levels apparent at LSS transducer
Time signal showing impacting
Endoscopy recommended
HSS damage suspected

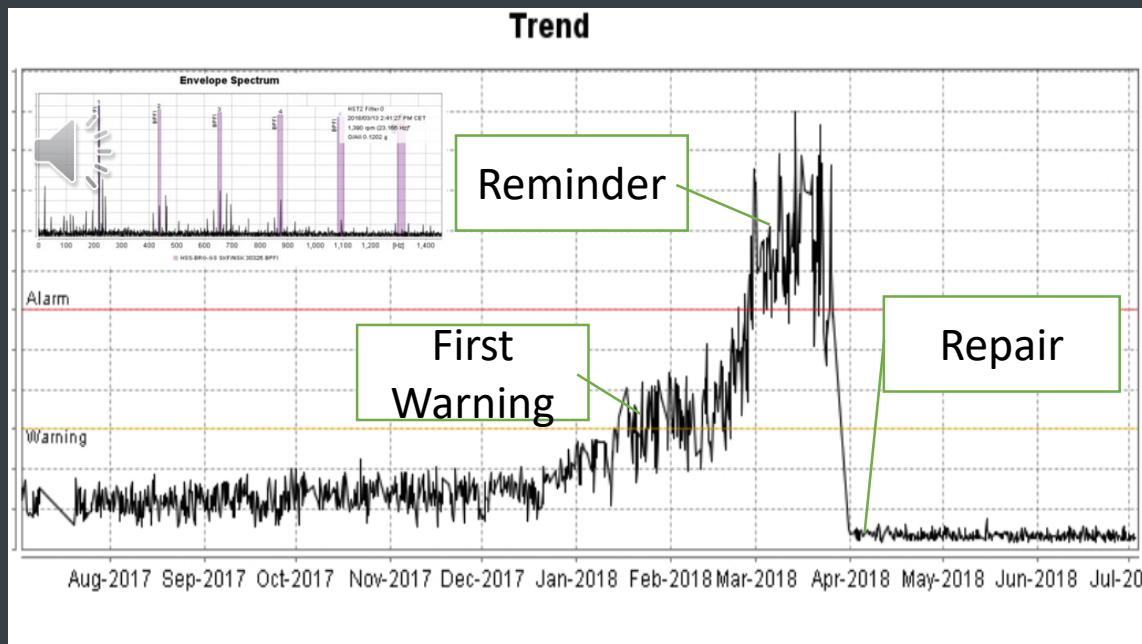


Endoscopy performed
Damage confirmed
Gearbox bearings replaced
Minimal downtime
Vibration reduced



Case Study: HSS Inner Ring Defect

- A HSS defect was noted
- Damage initiation possibly present when monitoring began
- First indication after the warning level was exceeded in February 2018
- Allowed the customer to plan a repair

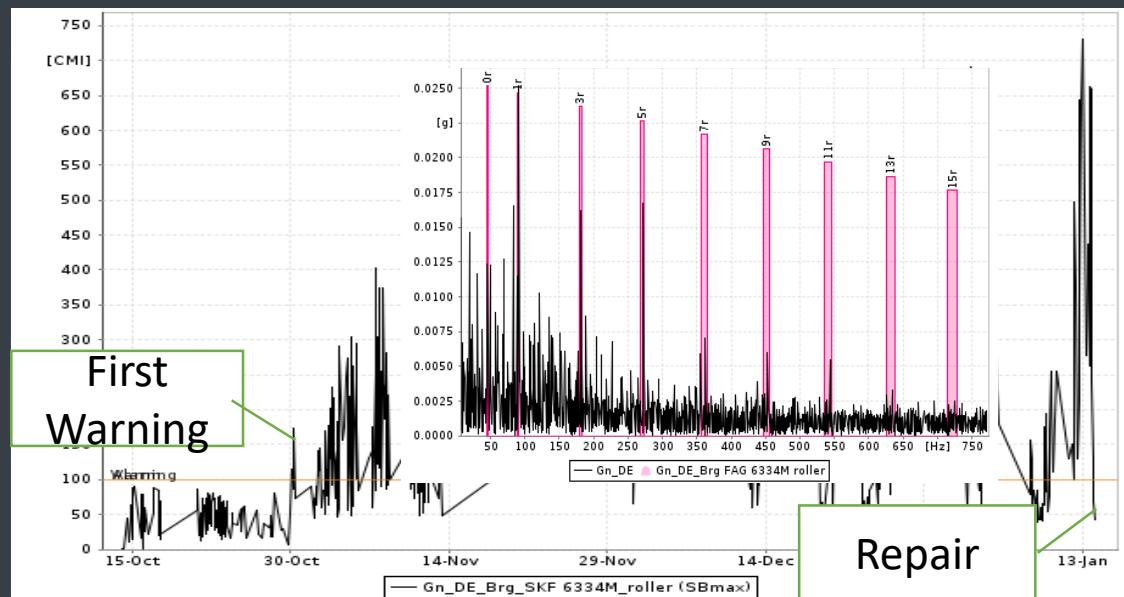


- Intervention at ideal time
- Damage beginning to trend, but at this point minimal consequential damage
- Advance warning meant that the teams were ready to make the exchange with minimal loss of production when the damage began to increase



Case Study: Generator bearing

Bachman identified ball spin frequency in signal
Diagnosed roller damage
Progression relatively slow
Repair made when progression accelerated



Customer scheduled exchange when convenient
Spall from single ball
Can result from water in grease
Original material defect also possible



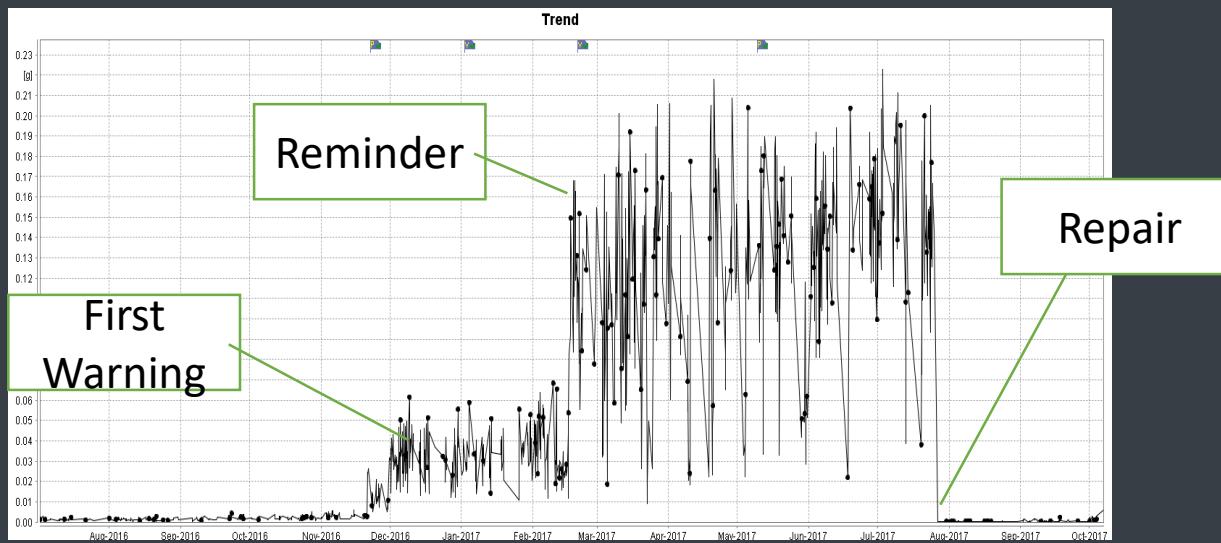
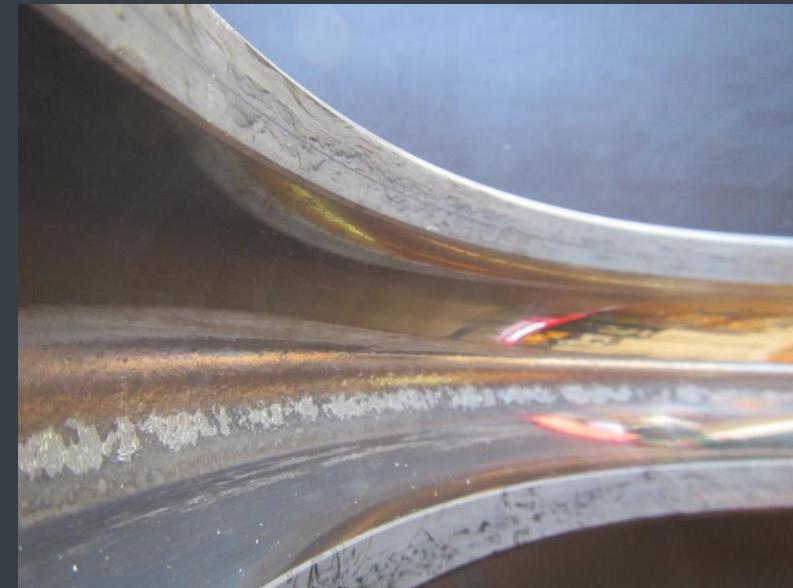
Case Study: Generator bearing

Bachman identified bearing defect frequencies

Diagnosed bearing damage

Two clear progression events

Repair made when convenient



Customer scheduled exchange for summer
Spall from single ball
Damage to both races



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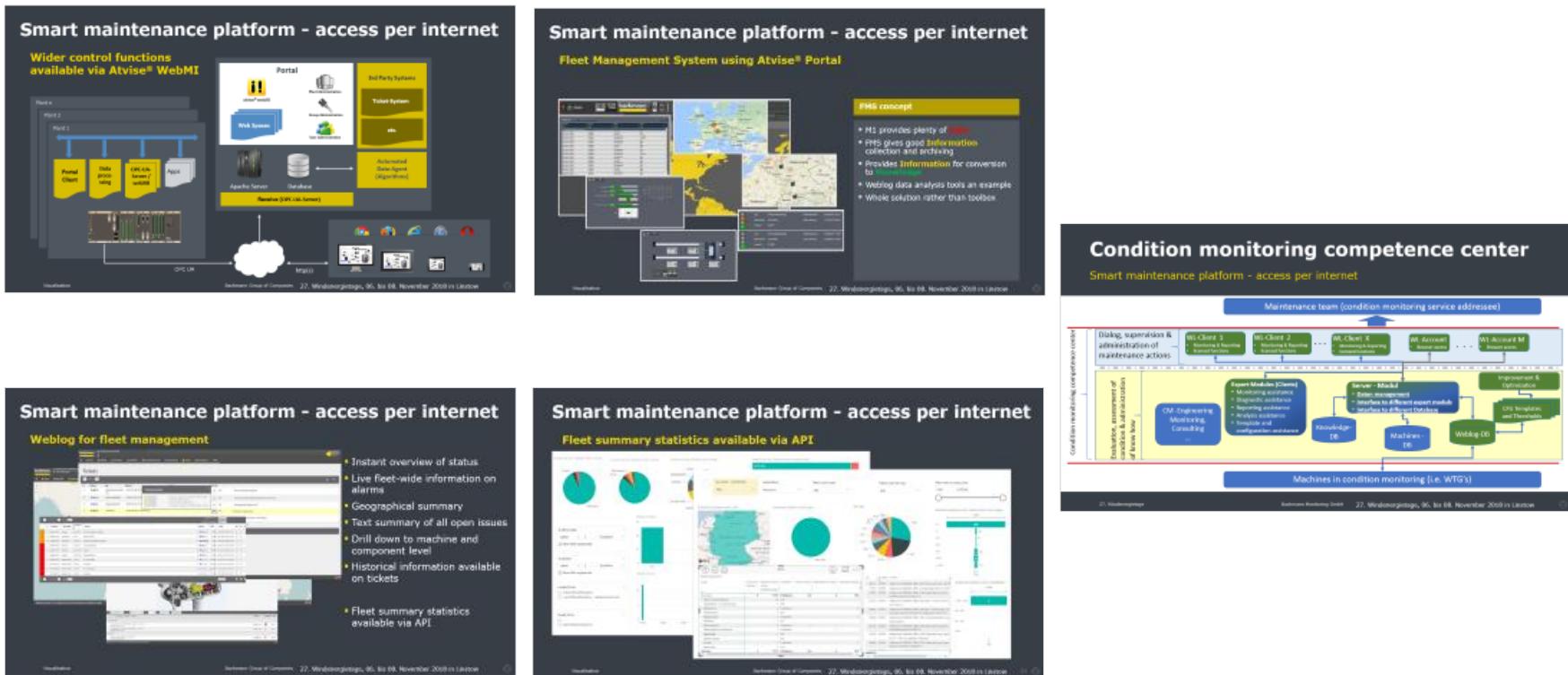
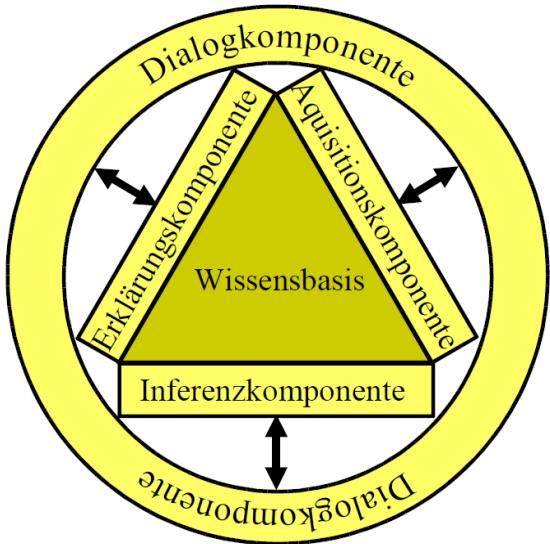
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Condition monitoring competence center

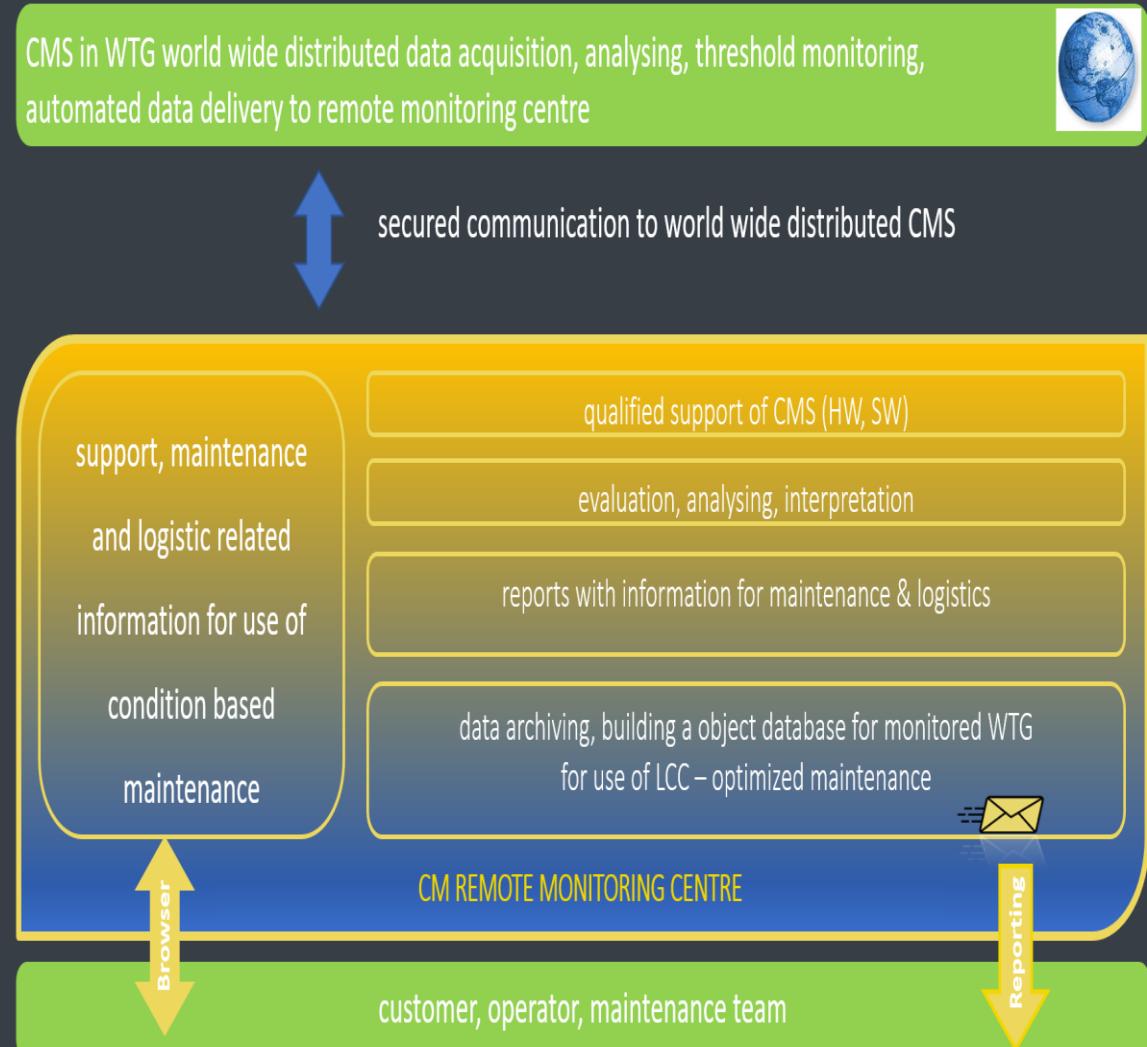
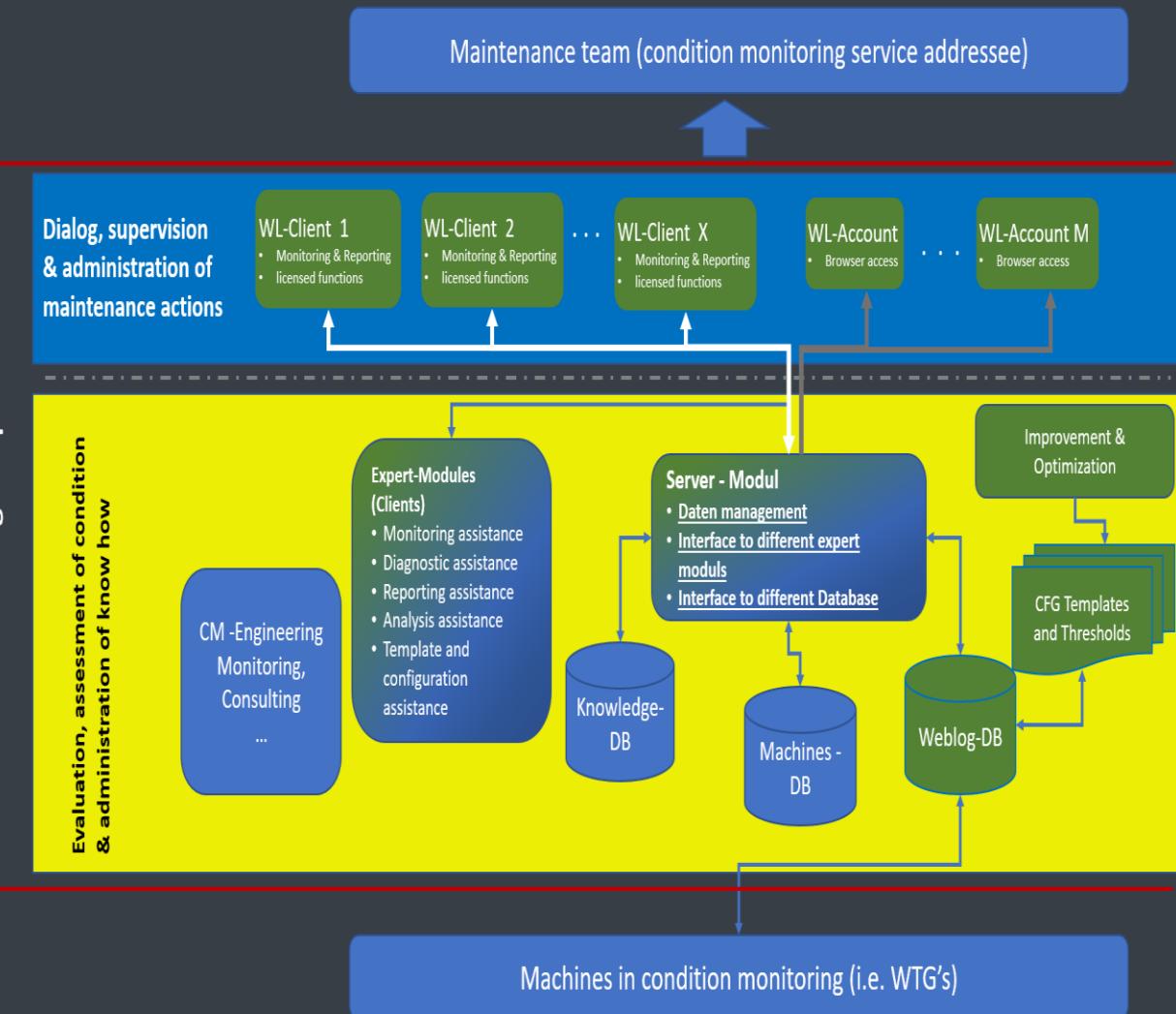
Smart maintenance platform - access per internet



- Strukturieren
- Abstrahieren
- Schematisieren
- Formalisieren
- Programmieren



Condition monitoring competence center



Herzlichen Dank für Ihrer Aufmerksamkeit

„Schwingungen zeichnen sich dadurch aus, daß sie nahezu alle Schädigungen, Fehler und den Verschleiß der Maschine widerspiegeln“ [Quelle: Dr. Weigel und Olsen Schwingungsseminare Band 3]



bachmann.



Bachmann Monitoring GmbH
Fritz-Bolland-Straße 7
07407 Rudolstadt

Tel: +49 3672 /3186 100
Fax: +49 3672 /3186 200

<http://www.bachmann.info>

Michelangelo auf die Frage wie er zu einer Skulptur kommt:

“Die Figur war schon in dem rohen Stein.
Ich mußte nur noch alles Überflüssige
wegschlagen”

